Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Directorate of
Intelligence

Confidential

25X1

Chromium: Western Vulnerabilities and Options

25X1

An Intelligence Assessment

Not referred to DOI. Waiver applies.

Confidential

GI 83-10019
February 1983

Copy 451

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Page Denied

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Directorate of
Intelligence

Confidential
[redacted] 25X1

Chromium:
Western Vulnerabilities and Options [redacted]

25X1

An Intelligence Assessment

This assessment was prepared by [redacted] 25X1
with a contribution from [redacted] Office of 25X1
Global Issues. Comments and queries are welcome
and may be addressed to the Chief, Commodity Markets
Branch, Economics Division, OGI, [redacted] 25X1

Confidential
GI 83-10019
February 1983

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

 25X1

Chromium: Western Vulnerabilities and Options 25X1

Key Judgments

Information available as of 15 December 1982 was used in this report.

Chromium is irreplaceable in stainless steel; substitutes in tool steels, superalloys, catalysts, and other uses are more costly and less effective. In the past, supplies from South Africa, the Soviet Union, Albania, and Zimbabwe have been readily available. Nevertheless, the high degree of Organization for Economic Cooperation and Development (OECD) dependence on these countries remains a source of concern:
- Southern Africa's severe economic, social, and political problems might disrupt mining and transport activities in one or more countries of the region at any time.
- The USSR could embargo chromite exports to the West as it did during the Korean war.
- Albania might shift its political and economic partners for ideological reasons—as it has already done twice in the last 30 years. 25X1

We believe the likelihood of any of these events occurring is rather small. Moreover, the OECD countries could do without chromium from southern Africa, the Soviet Union, and Albania indefinitely without serious harm to defense and critical civilian industries. Although the price of chromium would rise substantially in the event of supply disruptions, this rise would have little effect on consumers because chromium represents only a small fraction of the total cost of its end products. 25X1

In our judgment, a disruption of as long as six months could be easily managed at this time by virtue of the large commercial stocks and unused capacity created by the current recession among non-Communist world producers outside southern Africa. With economic recovery, a short-term loss of chromium supplies would require some conservation and substitution and greater recycling. Temporary government intervention and/or the reduction in demand caused by higher prices would assure the allocation of available chromium supplies to vital uses. 25X1

A long-term loss of supplies would require substantial changes in chromium industries and end uses. The United States, for its part, could release chromium from its strategic stockpile until such measures were implemented:

- The OECD countries would expand exploitation of non-Communist resources outside southern Africa, which now total over 500 million tons—more than enough to satisfy their requirements for the rest of the century. The United States could tap large, low-grade chromite resources in several western states to meet most of its needs for 10 years or more.

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

[redacted] 25X1

- New ferrochromium alloy facilities could be built in one or two years in the industrialized West or in two or three years in undisrupted chromite-producing less developed countries (LDCs) with technology now possessed by West European and Japanese firms.

- One-third of current US chromium needs could be eliminated by available substitutes, conservation, and recycling techniques; technological developments over the next 10 years might do away with another 45 percent. [redacted] 25X1

The Soviet Union would benefit from a disruption of chromium supplies from southern Africa. After 1985 it might even be able to expand its own exports to capture disrupted markets. It might do so selectively, however, as a means of nurturing economic and political ties with key Western countries. Large-scale exports during a prolonged disruption would in turn serve to increase Western dependence on the East by discouraging the development of alternative sources. [redacted] 25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

25X1

Contents

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

[redacted] 25X1

Chromium Uses and Market Structure

A number of critical industries and consumers would risk serious damage if chromium supplies were cut off. More than 60 percent of OECD consumption is related to metalurgical *uses, the most important of which is to give stainless steel its resistance to oxidation and corrosion, especially at high temperatures. Chromium is also added to tool steels and superalloys to increase their strength, workability, and wear. These steels have critical defense applications in airframes and jet engines. They also have vital functions in food-processing equipment such as holding and transport tanks, chemical and petrochemical processes where corrosive materials are handled, medical instruments, and consumer durables such as automobile engines and catalytic converters and household equipment and appliances* [redacted] 25X1

Chromium also has important chemical *uses in metal plating, leather tanning, water purification, pigments for paints, and mud used in drilling oil and gas wells and as a catalyst. In many of these applications, substitutes are either unknown or more costly and less effective. High-alumina chromite is used primarily to make brick* refractories *for open hearth and other types of furnaces. This use will decline as open hearth furnaces are phased out of steel production.* [redacted] 25X1

Most chromium used in the manufacture of alloy steels is in the form of various ferroalloys. The chromite is smelted in a submerged-arc electric furnace to produce charge chrome (50 to 60 percent chromium), high-carbon ferrochromium (60 to 72 percent chromium), low-carbon ferrochromium (65 to 75 percent chromium), and ferrosilicochromium (35 to 41 percent chromium). The first two are generally produced from cheaper high-iron ore, while low-carbon ferrochromium requires the more expensive high-chromium ore. [redacted] 25X1

With the development of advanced processes for producing stainless steel, the use of low-carbon ferrochromium and ferrosilicochromium has dropped significantly over the past decade in favor of cheaper charge chrome and high-carbon ferrochromium. This has greatly benefited those countries with the lower quality chromite deposits, particularly South Africa. Chromium metal is also used for metallurgical purposes but in much smaller quantities. [redacted] 25X1

Because stainless and other alloy steels account for most chromium consumption, the cyclical and long-run level of chromite demand is closely linked to their production. We estimate that non-Communist chromite consumption in 1981 was roughly 6 million tons, almost 25 percent below its peak level in 1979. The continuing severe world recession, particularly the near-collapse of steel output in the industrial countries, probably reduced consumption further in 1982. Consequently, there is now much slack capacity among producers. US commercial stocks of chromite equaled more than 75 percent of annual consumption at the end of 1981. Although little information is available, stocks in other industrial countries are also believed to be high. Moreover, India, Finland, Madagascar, Turkey, and Brazil by this time probably have large producer stocks and would welcome an opportunity to reduce these without competition from South Africa. [redacted] 25X1

This situation will persist until economic activity in the OECD countries picks up momentum. The average annual rate of growth of non-Communist demand for chromium is likely to range between 3.0 and 3.5 percent for the rest of the century.[a] *At this rate, chromite consumption could rise to about 11.5 million tons by 1990,*[b] *well within producer capabilities if normal expansion plans are pursued.* [redacted] 25X1

[a] The US Bureau of Mines estimates that the average annual growth rate of world demand for chromium for the rest of the century could be as low as 2 percent or as high as 4 percent. The most likely level is placed at 3.3 percent (see US Bureau of Mines, *Chromium, Preprint From Bulletin 671, 1980).* Other estimates are lower: Malenbaum—3.0 percent (Wilfred Malenbaum, *World Demand for Raw Materials in 1985 and 2000,* New York: McGraw Hill Inc., 1978); National Materials Advisory Board—2.3 percent (NMAB, *Contingency Plans for Chromium Utilization,* Washington: National Academy of Sciences, 1978); Resources for the Future—2.25 percent (Leonard L. Fischman, *World Mineral Trends and US Supply Problems,* Washington: RFF, 1980). [redacted] 25X1

[b] This is based on 1978 non-Communist consumption of primary chromium of about 2.3 million tons and assumes that the average chromium content of chromite will remain 30 percent [redacted] 25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

[redacted] 25X1

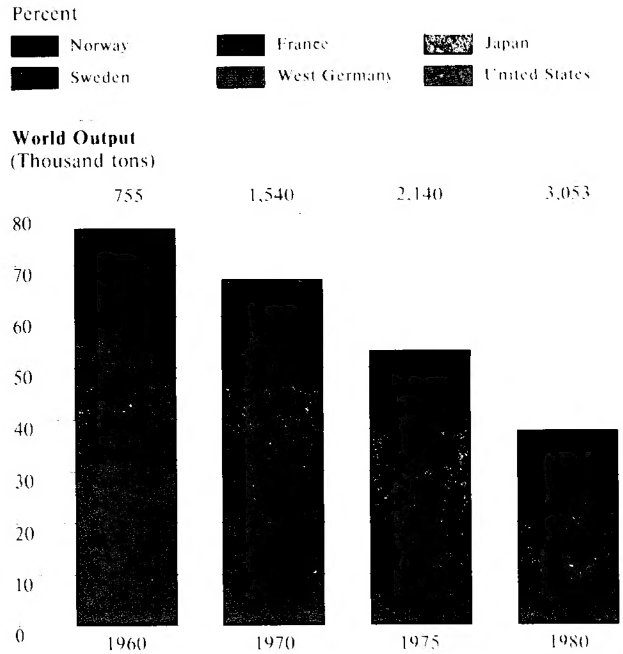
Chromium: Western Vulnerabilities and Options [redacted] 25X1

Introduction

Chromium is perhaps the most strategic of all metals. There are no substitutes for many of its critical metallurgical and chemical uses. Output of chromite, the ore from which chromium is extracted, is highly concentrated in a few countries. South Africa, the USSR, Albania, and Zimbabwe account for almost three-fourths of world production.[1] OECD countries produce less than one-tenth of world output, and that comes mainly from Finland and Turkey. Other important producers include India, the Philippines, Madagascar, and Brazil. [redacted] 25X1

The major OECD consuming countries depend on imports from southern Africa for more than half of their chromium needs. The region has an abundance of cheap chromite and a record of reliable delivery. Before 1970, chromite-producing countries shipped most of their output to OECD countries for conversion into ferrochromium alloys. Since then alloy production has largely shifted to the mining countries because of their lower energy and labor costs, fewer environmental constraints, and desire to capture more of the value added to chromium products (figure 1). Savings also accrue because the alloys are cheaper to ship than the bulk ore. South Africa is especially blessed by its huge reserves of low-grade chromite that can be used to make low-cost charge chrome and high-carbon ferrochromium, both of which are well suited to the production of stainless steel with current technology. [redacted] 25X1

Figure 1
Major OECD Ferrochromium Alloy Producers Share of World Output, 1960-80



[redacted] 25X1

588524 2-83

Impact of Market Disruptions and Price Increases

Although the availability of chromium from southern Africa has been quite reliable, confidence in future access to this resource is reduced by the region's grave economic, social, and political problems. These problems have already impeded mineral development and output in Angola, Mozambique, and Zaire and might well affect chromium production and export in South Africa and Zimbabwe during the 1980s. Nor is availability from the other two major suppliers, the USSR and Albania, assured (see appendix A). [redacted] 25X1

Because no major disruption of the chromium market has ever occurred, the extent and nature of the consequences can only be surmised. The Soviet chromite embargo during the Korean war as well as the

[1] In this paper chromite output is measured in terms of beneficiated ore or concentrates. Data presented here, therefore, may differ from those published elsewhere for certain countries, particularly the Soviet Union, which report statistics on run-of-the-mine output only. [redacted] 25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

disturbance of Zairian cobalt production in 1977 and 1978 do, however, provide some experience with the curtailment of critical mineral supplies. This experience suggests that the impact of such disruptions is likely to be smaller than anticipated because of the ability of governments and the marketplace to bring about development of new chromium sources and because of increased recycling, substitution, and conservation. Moreover, defense needs and critical civilian uses account for only a part of the consumption of strategic materials such as chromium. These could be easily met in any crisis while less essential and frivolous uses are restricted or eliminated.

Any likely increase in prices caused by collusion or supply disruptions would not greatly decrease demand for chromium. At least half of this demand is for stainless steel and is relatively inelastic with respect to price. Because chromium accounts for only 5 percent of the cost of stainless steel, tripling the price of chromite would raise the price of the steel by only 10 percent. Stainless steel has no substitutes for some of its applications and only expensive and less suitable substitutes for others; such a small increase in price would hardly affect its use. A US Government–sponsored study concludes that a chromite price increase of 2,000 percent would be needed to halve demand for stainless steel.[2] Other chromite uses are much more price elastic. In all, the study estimates that tripling its price would cause chromite demand to fall by 25 percent.

Short-Run Disruption of Chromium Supplies. We believe that a loss of chromium supplies from southern Africa that lasted no more than six months could be borne without cutting supplies for essential uses in the OECD countries, even if accompanied by embargoes of exports by Albania and the USSR. During the current severe economic recession, a short-term loss would be especially easy to manage because of the relatively low level of demand.

Ferrochromium alloy capacity in the non-Communist world outside southern Africa is sufficient to have satisfied almost all non-Communist demand in 1979, the last peak year, and could easily satisfy the current depressed demand. Non-Communist *chromite* capacity outside of southern Africa could supply more than half of the current needs of the Western countries. In addition, stocks of chromite and alloys among non-Communist producers outside of Africa are relatively high and could help to cushion the shock. Prices would rise somewhat as markets became reorganized, but increases would be moderated by the large overhang of producer inventories, the use of slack capacity, and the expected resumption of exports from southern Africa at the end of the crisis.

25X1
25X1

A short disruption occurring later in the 1980s would pose greater difficulties but could still be managed. Non-Communist production of chromite and alloys outside Africa is likely to shrink through the decade, while needs increase. Dwindling unused capacity and stocks would not be able to replace the loss of supplies from southern Africa. Prices would rise faster, and increased recycling, conservation, and substitution would be needed to balance supply and demand. Higher prices along with some government intervention would assure rapid reallocation of available chromium supplies to essential defense and critical civilian uses. Less essential uses of chromium might be banned or postponed. As much as one-third of US chromium demand could be eliminated through the use of already available substitutes, but the expectation of renewed exports from southern Africa in a short time would discourage methods and materials requiring a large investment of time or money.

25X1
25X1

Long-Run Disruption of Chromium Supplies. The loss of chromium supplies from southern Africa accompanied by the embargo of exports from Albania and the USSR could be managed even if these disruptions were expected to last indefinitely, but would require substantial restructuring of chromium industries and uses. Available stocks and capacities would be inadequate. It would be necessary to expand the capacities of other producers, to increase recycling, to develop new chromite sources, to eliminate nonessential uses, to reduce waste, to decrease the chromium content of products, and to substitute other metals for chromium and other materials for chromium products.

25X1
25X1
25X1

[2] National Bureau of Standards, 1976, Charles River Associates, *The World Chromite Market,* Washington, D.C.: National Bureau of Standards, 1976, p. 4-11a.

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

These changes would require time and great expense and would result in higher product cost and poorer performance. Since they would not be maintained if cheap chromite and ferrochromium alloy exports from South Africa resumed, most of the changes would be attempted only if the disruption appeared certain to last at least five years. Without this assurance chromium prices would have to rise very high indeed to provide enough short-term gain to commercial interests to induce them to make the effort needed to bridge a supply disruption of intermediate length.

Governments in the industrial countries would probably act to mitigate high prices and to assure the availability of chromium for critical uses throughout the crisis. Strategic stockpiles could be released. France, Japan, and perhaps Sweden maintain stockpiles of chromium equal to several months' current consumption. The US stockpile is equal to 150 percent of US metallurgical and chemical chromium consumption in 1979, the year of peak consumption. If available conservation and substitution methods were quickly introduced, the stockpile of metallurgical and chemical chromium could last more than two years at the 1979 level of demand, long enough to bring new chromite mines into operation.

Because there would be pressure to share these strategic stocks with allied countries, governments might well seek to develop new sources of chromite as quickly as possible. The United States has large resources in Montana, Oregon, and other western states; other OECD countries would probably turn to resources in Third World countries. Indeed, France, West Germany, and Japan are already encouraging efforts by their nationals to develop mineral resources in the LDCs in hopes of expanding and diversifying sources of strategic minerals.

The US Bureau of Mines estimates that a five-year loss of chromium supplies from southern Africa, Albania, and the Soviet Union—assuming chromite capacity elsewhere grew by only 10 percent a year—would cause the price to rise, peaking in the fourth year of the crisis 11 times higher than it would have otherwise. This increase would reduce chromium consumption and would cost the United States about $4 billion over eight years. Since chromite capacity, however, could be expanded by more than 10 percent a year in a number of non-Communist countries outside southern Africa, the impact of a cutoff on price is probably overestimated, and the overall cost to the United States would probably be lower. National Material Advisory Board (NMAB) analysis suggests 25X1 that the 30-percent reduction in chromium supplies that would be sustained by the metallurgical industry could be borne without serious consequences.

Supply Alternatives

Proven non-Communist chromite resources outside 25X1 southern Africa total more than 500 million tons, more than enough to satisfy likely Western requirements for the rest of the century (table 1). Resource estimates are probably conservative; chromite ores are difficult to identify and measure, and there is generally little incentive to explore for them as long as cheap, abundant South African chromite is available. Indeed, known resources outside southern Africa have doubled in the last decade, growing faster than non-Communist demand:

- India's resources have expanded from only 13 million tons to more than 100 million tons.
- Brazil's resources have grown 90 percent to 22 million tons.
- Finland's resources have risen from 15.5 million to 25X1 75 million tons.
- Turkish resources are estimated to be 150 percent greater.
- Madagascar, Papua New Guinea, and Yugoslavia have recently discovered large chromite deposits.

Additional discoveries are likely to augment known resources greatly by the end of the century as LDCs attempt to assess their mineral wealth. 25X1

The United States has an estimated 241 million tons of chromite resources, according to the US Bureau of Mines. These, however, contain only 10 percent chromium, well below the 30 to 50 percent in ores 25X1 commonly mined, and would not be commercially worth exploiting unless the price of chromite were to rise at least 300 percent. They could provide as much as 500,000 tons of chromium annually, three-quarters of US demand in 1979. Such output, however, could be sustained for only five to 10 years before declining ore grades caused costs to rise even higher. 25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Table 1 [a]
Chromite Resources, 1981 [b]

Region	Estimated Reserves *(million tons)*	Total Resources *(million tons)*	1981 Output *(percent of reserves)*	Average Annual Growth Rate of Resources 1973-81 *(percent)*
World	**3,635** [c]	**33,056** [c]	**0.3**	
Market economy countries	**3,359** [c]	**32,754** [c]	**0.2**	
North America	0	251		
Canada	0	10		18
United States	0	241		8
South America	2	22		
Brazil	2	22	20.4	9
Colombia	NA	NA		
Western Europe	30 [c]	110 [c]		
Cyprus	NA	NA		
Finland	25	75	1.6	22
Greece	NA	NA		
Greenland	0	10		
Turkey	5	25	8.0	12
Africa	3,272 [c]	32,236 [c]		
Madagascar	2	12	8.0	2
South Africa	2,270	22,224	0.1	28
Sudan	NA	NA		
Zimbabwe	1,000	10,000	0.1	32
Asia-Oceania	55 [c]	135 [c]		
India	50	100 [c]	0.3	29
Iran	2	12	1.5	21
Japan	NA	NA		
New Caledonia	NA	NA		
Pakistan	NA	NA		
Philippines	3	23	14.8	15
Communist countries	**276** [c]	**302** [c]	**1.3**	
Albania	2	18	57.2	
Cuba	3	13	1.0	33
USSR	271	271 [c]	0.9	NA
Vietnam	NA	NA		

[a] Source: US Bureau of Mines and CIA estimates.
[b] Resources include those chromite deposits that are currently or potentially exploitable. Reserves include only those ores that are economically worthwhile to exploit given current prices and technology.
[c] Minimum level; data for some countries are incomplete or not available.

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

South Africa is aggressively expanding its chromite production and could add considerable capacity very quickly at little or no increase in the relatively low unit cost. Other countries are also expanding their capacities:

- Industry reports indicate that Brazil could add 225,000 tons to its chromite capacity by 1987.
- Greece is expanding its chromite capacity by 50,000 tons.

[redacted]

- The Sudan is increasing its chromite capacity by 80,000 tons.

Other countries that have recently discovered large new chromite resources would probably expand their production capacity if the price incentive were sufficient. [redacted]

Ferrochromium alloy capacity could also be rapidly expanded. Much new investment is already scheduled outside southern Africa, relying on the technical and financial help of Western companies (table 2). This expansion is now slowed because of weak market conditions but could be accelerated if conditions warranted. US firms are involved in ferrochromium alloy production in Zimbabwe and South Africa, areas of potential difficulty. Japanese companies are facilitating expansion programs in Brazil, Turkey, and South Africa and developing chromite mines in Madagascar and the Sudan. [redacted]

If this planned capacity should prove insufficient to meet demand, new facilities could be built in one or two years in the industrial West or in two to three years in undisrupted chromite-producing countries [redacted] These facilities would have somewhat higher operating costs than those in southern Africa and would not be built by private firms unless the disruption were expected to last at least five years or government assistance were forthcoming. Along with existing capacity and that already under construction, the new plants could satisfy non-Communist demand for ferrochromium alloys as long as the supply of chromite remained adequate. [redacted]

Table 2 [a]
Planned Expansion of Ferrochromium Alloy Capacity

Country	Capacity *(thousand tons)*	Status
Albania	100,000	In progress
Brazil		Under consideration
Finland	5,000	In progress
Greece	33,000	Scheduled for completion in 1983
India	100,000	Scheduled for completion by 1984
	100,000	Under consideration
Madagascar		Under consideration, needs funding
Philippines	50,000	Scheduled for completion in 1983
Sudan		Feasibility study, needs funding
South Africa	100,000	Could be added very quickly
Turkey	50,000	Scheduled for completion in 1984
Zimbabwe	50,000	Under consideration

[a] Source: International Iron and Steel Institute, Brussels, March 1981, *Chromium and the Steel Industry*.

[redacted]

Technological Changes

The NMAB estimates that one-third of current US chromium requirements could be eliminated by available substitutes and conservation techniques (figure 2). Technological developments over the next 10 years could do away with another 45 percent. These changes would raise costs and lower performance and therefore will not occur as long as cheap chromite and ferrochromium alloys from South Africa are available. [redacted]

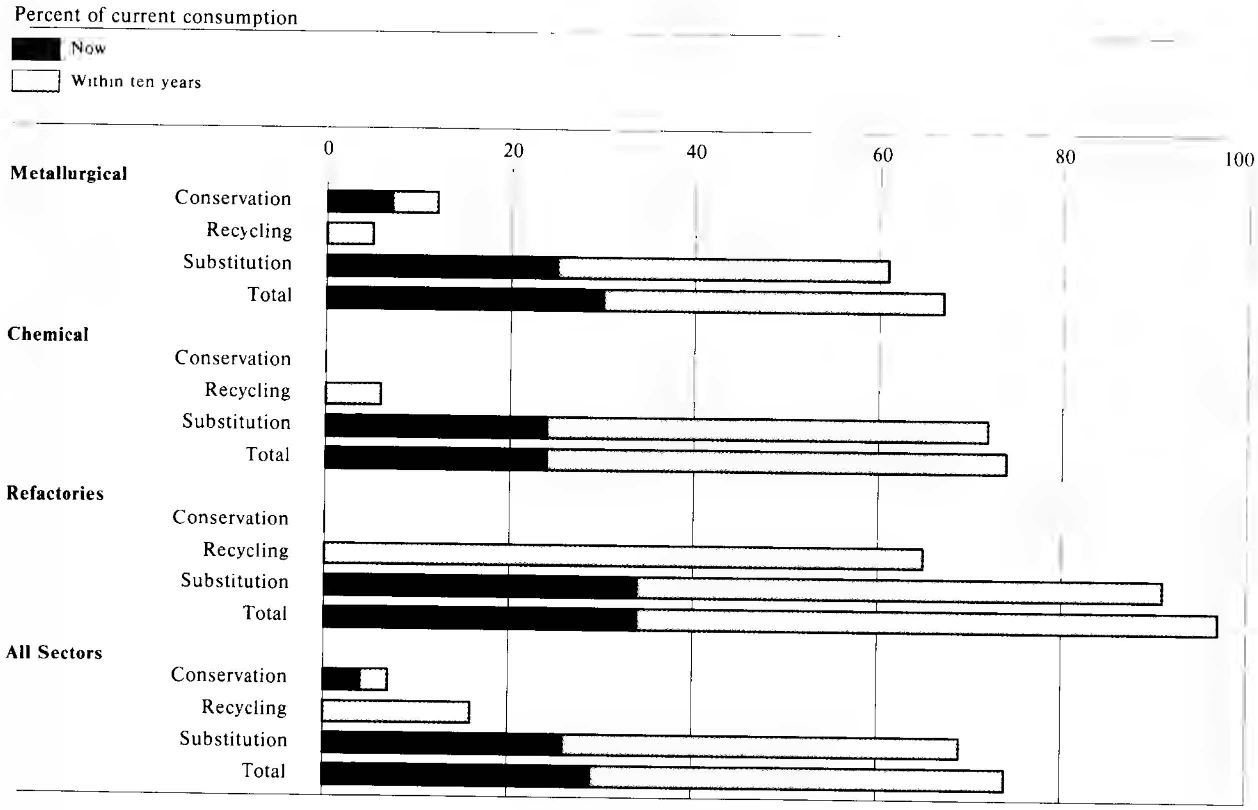
According to the NMAB, US metallurgical uses of chromium could be cut 7 percent through conservation techniques already available. Processing losses can be reduced by the use of die forgings, computer-aided design and manufacturing, and near-net-shape casting and powder metallurgy. The trend to lighter, smaller vehicles with advanced emission controls will also reduce the need for chromium. Another 5 percent

25X1
25X1
25X1
25X1
25X1
25X1
25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 2
US Potential Savings of Chromium-Containing Materials



25X1

588525 2-83

of US metallurgical consumption could be eliminated within 10 years through the further development of other technologies, including:
- Ion implantation.
- Cladding.
- Surface modification.
- Hot isostatic pressing.

Only 10 percent of US chromium needs are now met by recycling, and as long as the price remains low additional recycling efforts will not be attractive. The NMAB believes, however, that technological innovations over the next 10 years could make possible the recycling of 5 percent of the chromium used in US metallurgical applications, 6 percent of that used for chemical purposes, and 65 percent of the chromium used in US refractories. 25X1

Available substitute materials for many chromium uses are either more costly, less effective, or themselves subject to supply disruption. Higher chromium prices, however, would make them acceptable. NMAB estimates indicate that these materials could replace a quarter of the chromium used in US

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Substitutes for Chromium

Chromium can be replaced in some of its applications. Nickel, molybdenum, cobalt, silicon, and aluminum could give steel much of the corrosion resistance now provided by chromium. Vanadium could also be used to replace chromium in some tool steels. Most of these metals, however, are more costly than chromium. No suitable substitutes are available for chromium in superalloys. Moreover, the United States depends on imports for most of its aluminum and cobalt, and the strategic stockpiles of cobalt, aluminum, and vanadium are below US goals. [redacted]

In chemical applications, chromium can be replaced by high-impact polymers, zinc, or aluminum for plating purposes only if abrasion and corrosion resistance are not required. Substitutes perform more poorly as paint pigments. There are no known substitutes for chromium in drilling muds, water treatment, or leather tanning. [redacted]

In products where chromium is irreplaceable, other end products can often be substituted. Stainless steel, the main use of chromium, has various substitutes. For decorative purposes or in noncorrosive environments, it may be replaced by oxidized aluminum, epoxy- or glass-coated carbon steel, plastic, aluminized steels, or by copper, zinc, and aluminum alloys. In corrosive environments, various alloy steels and titanium are possible substitutes. In corrosive, high-temperature environments, titanium alone is available. These substitutes, however, cost so much more than stainless steel that even a many-fold increase in the price of chromite would have relatively little effect on its competitive advantages. [redacted] 25X1

Future developments may create other substitutes for chromium. Promising materials include:
- *Fiber-reinforced plastics.*
- *Other polymers.*
- *Low-chromium and chromium-free alloys for less critical applications.*
- *Ceramics, including glass.*
- *Composite materials.*
- *Superplastic metals.* [redacted]

25X1

25X1

metallurgical and chemical applications and one-third of that employed in refractories. Technological developments over the next 10 years could permit replacement of an additional one-third of current metallurgical usage, one-half of the chromium used in chemical applications, and one-half of that used for refractories. [redacted]

[redacted]

25X1

[redacted]

25X1

25X1

25X1

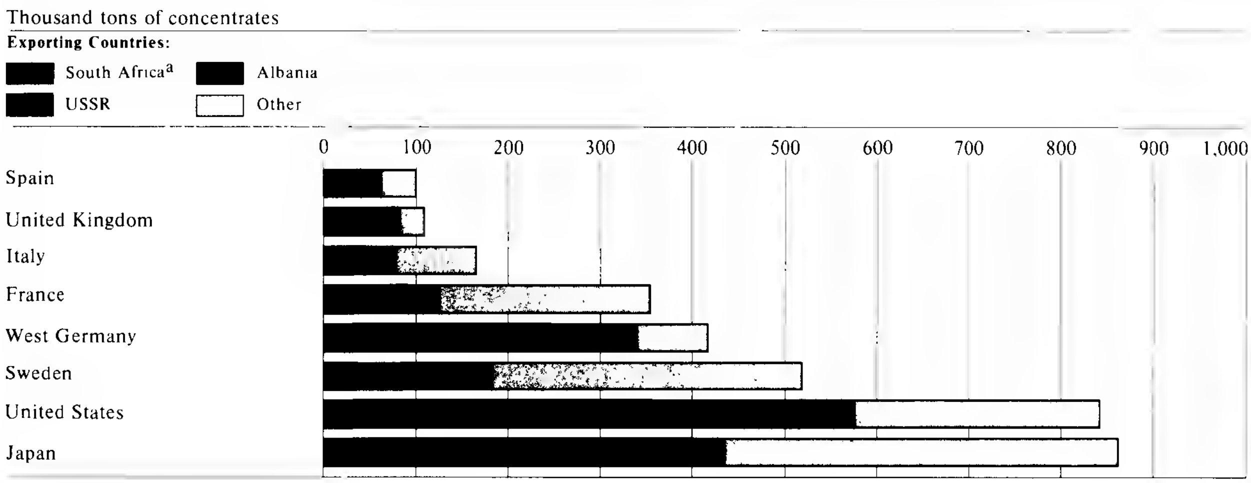
[redacted]

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 3
Chromite Import Sources for Major OECD Users, 1978-81



[a] May include imports from Zimbabwe.

25X1

588526 2-83

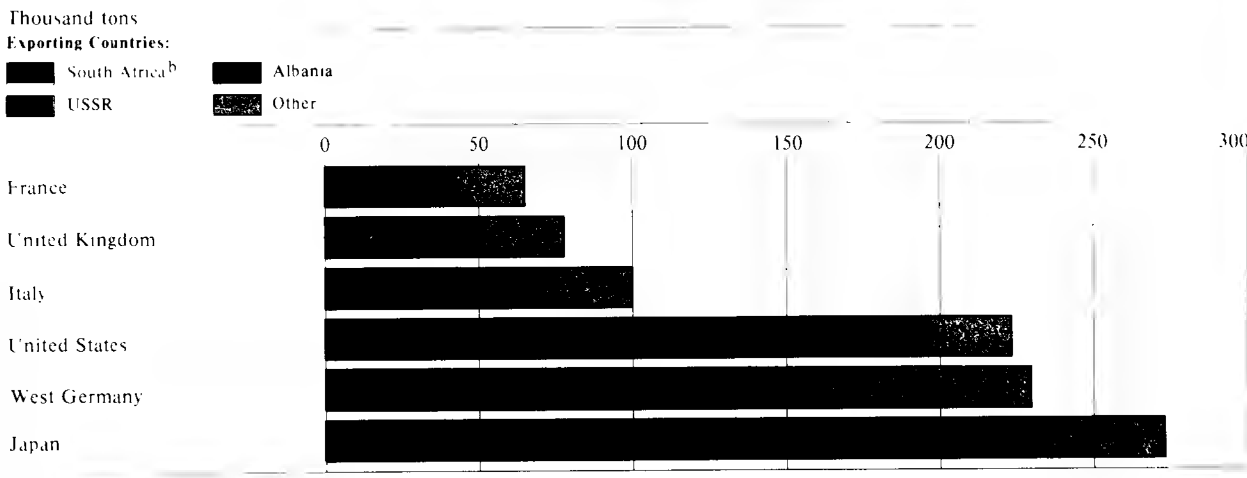
25X1

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 4
Ferrochromium Alloy Import Sources for Major OECD Users, 1979[a]



[a] Includes direct shipments and imports of ferrochromium alloys from third countries that rely on the source country for chromite

[b] May include imports from Zimbabwe

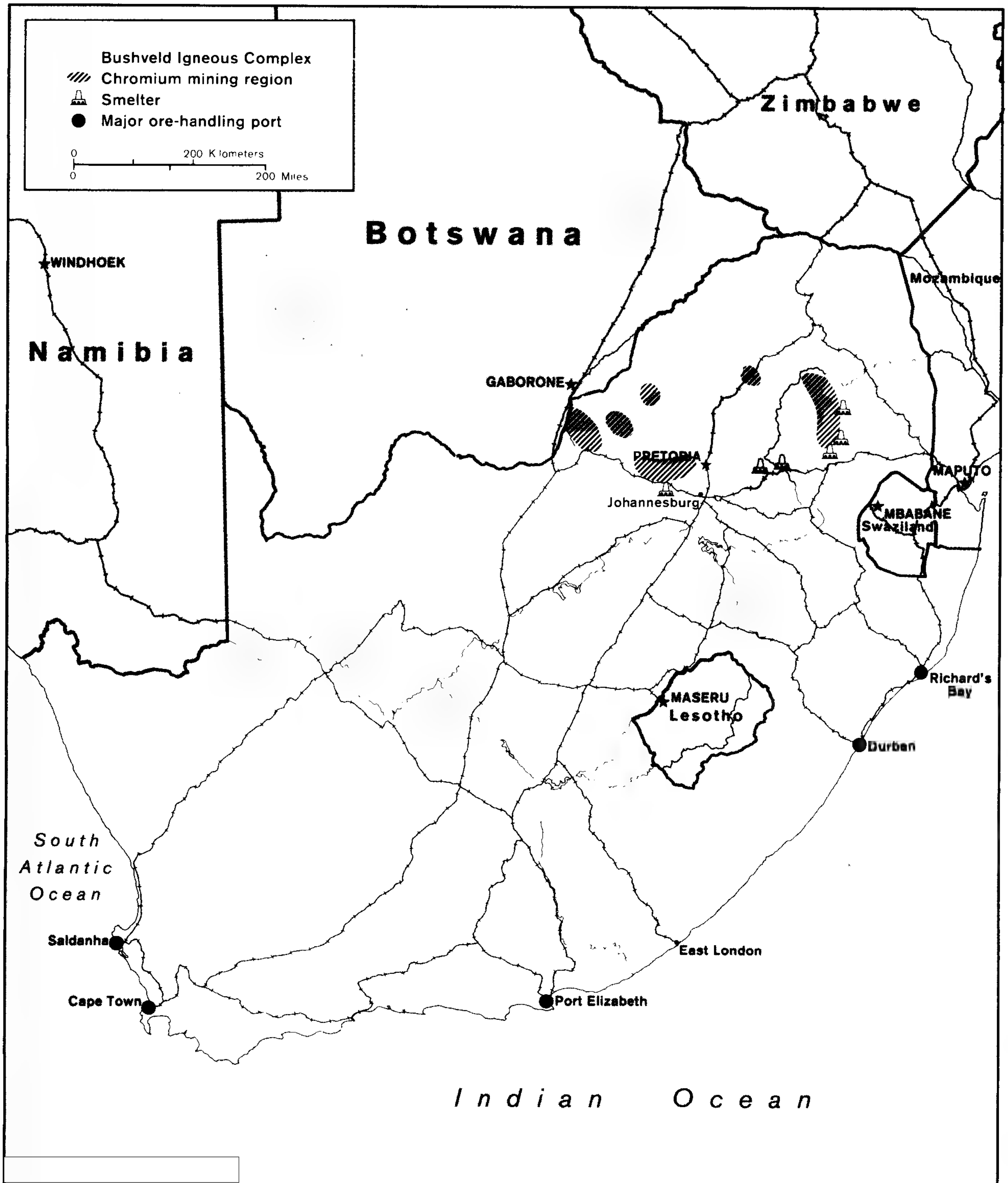
25X1

588527 2-83

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 5
South Africa: Major Chromium Facilities



633560 (A01864) 2-83

[redacted]

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Appendix A

Major Chromite Producers: Potential for Disruption

South Africa. South African chromite is concentrated in the vast Bushveld Igneous Complex, which also contains the world's largest known reserves of vanadium and platinum-group metals (figure 5). There are 18 active, widely dispersed mines, at least half of them each producing more than 200,000 tons of ore per year. Because no one or two mines dominate production, it would be extremely difficult for insurgents to cut off all mine output. South African security forces probably could quell any disruption rather quickly. 25X1

The situation is similar for the South African ferrochromium alloy smelters. The six alloy producers are also widely scattered, and annual smelter capacity ranges from 70,000 to 165,000 tons each. Power is abundant and comes from a variety of sources via a well-integrated grid. Insurgents would probably have to be satisfied with a limited disruption. Unless this was accompanied by damage to facilities, production shortages could be made up by on-site inventories. 25X1

We believe that it would be nearly impossible for insurgents to cut all supply routes to ports. South Africa's highly developed transportation network has few choke points and a number of alternative routes. Ferrochromium alloy facilities are linked by rail to several ports, only one of which, Maputo, is located outside the country. 25X1

Because of the recent growth of independent black trade unions, the most likely cause of disruptions to the chromium industry is labor disturbances. These could affect chromium production directly or might disrupt transportation services. Such disturbances, however, are likely to be only of short duration.

Any collusion among producers to raise the price of chromite would have to involve South Africa because of its dominance over the industry (table A-1). We believe, however, that South Africa would have little to gain from such action. It will probably continue to supply chromium at a reasonably low price so as to exploit its competitive advantage and expand its market share. Exports are already shifting to ferrochromium alloy as OECD competitors are driven out of the smelting business. Dominance in that market could support a highly competitive stainless steel and superalloy industry by the end of the century, which would substantially increase South Africa's industrial and commercial power. 25X1

Zimbabwe. Unlike South Africa, Zimbabwe has a number of vulnerable areas that could be exploited by insurgents (figure 6). Roughly 70 percent of the chromite output comes from two adjacent mines, Selukwe Peak and Railway Block. In addition, the two ferrochromium alloy facilities, one with a capacity of 180,000 tons per year and the other with a capacity of 210,000 tons per year, are only 60 kilometers apart. All of their power comes from the Kariba Dam, which supplies 70 percent of Zimbabwe's energy needs. In late 1983 the Hwange thermal power station will add substantially to Zimbabwe's energy resources, but not enough to make up for the loss of Kariba. 25X1

The transportation network in this landlocked country is also quite vulnerable. If insurgents severed the rail line just south of Gweru (Gwelo), they could effectively cut off traffic to South African ports, the major route for Zimbabwean chromium exports, and to Maputo in Mozambique. Zimbabwe would then be forced to export via Beira in Mozambique, which is ill equipped to handle the traffic. More importantly, the rail lines to Beira and Maputo are highly vulnerable to sabotage by Mozambican insurgents. 25X1

The USSR. The Soviet Union has for years sold the West a variety of minerals and metals—including such critical materials as chromite, platinum group

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Table A-1 [a]
Chromium Output of Key Producing Countries, 1980

Country	Product	Output [b] (*thousand tons*)	Value (*million 1980 US $*)	Share of World Output (*percent*)	Share of GNP (*percent*)
South Africa	Chromite	3,400	187	35	NEGL
	Ferrochromium	810	615	27	1
Soviet Union	Chromite	2,500	275	26	NEGL
	Ferrochromium	510	380	17	NEGL
Albania	Chromite	1,100	118	11	10
	Ferrochromium	15	11	NEGL	1
Zimbabwe	Chromite	552	61	6	1
	Ferrochromium	200	152	7	3

[a] Source: Chromite output, price, and world output share from US Bureau of Mines, *Chromium Preprint From the 1981 Minerals Yearbook*. Ferrochromium output, price, and world output share from US Bureau of Mines, *Ferroalloys Preprint From the 1981 Minerals Yearbook*. [redacted] 25X1 25X1

[b] Chromite output is measured in terms of chromite concentrates.

[redacted] 25X1

metals, titanium sponge, and manganese ore (figure 7). Soviet chromite exports, however, have declined considerably in recent years:

- Soviet raw material output growth is lagging.
- The severe economic recession in the industrial West has greatly reduced demand for chromite.
- Demand for Soviet chromite of declining quality has waned in the face of strong South African competition. [redacted] 25X1

Contrary to some popular commentary, we do not believe that the USSR is now engaged in any sort of resource war with the West or is likely to do so in the near future.[3] A Soviet chromite embargo during the Korean war did not noticeably damage Western industrial interests or harm the war effort because alternative sources were available in the United States and elsewhere. During the Vietnam war (1965-73), Soviet chromite exports to the United States increased dramatically. Hence, another Soviet-initiated embargo does not seem likely; however, it is possible that the USSR would withhold its chromite from the market to add to the impact of a disruption of supplies from southern Africa. [redacted] 25X1

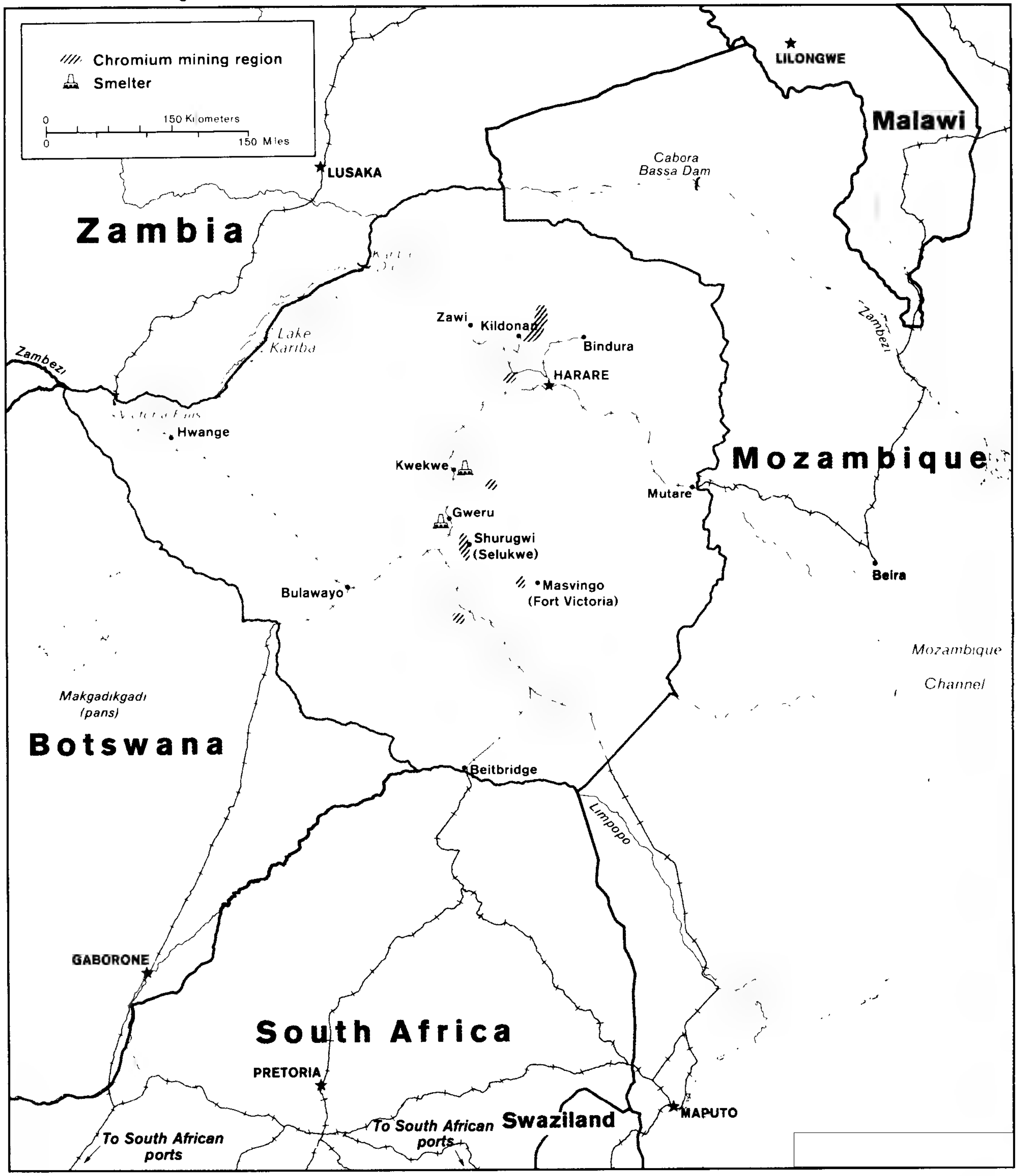
[redacted]

We believe it more likely that the USSR would continue to export chromite to take advantage of the higher prices created by a crisis. With the opening of a huge new deposit in Kazakhstan in 1985, it might even be able to expand exports to capture disrupted markets. It might do so selectively, however, making chromite available only to certain countries to increase its influence among them and to weaken the Western alliance. This would eventually benefit all consumers but would offer some competitive advantages to those doing business with Moscow. The availability of Soviet chromite in Western markets during a prolonged disruption would discourage development of alternative sources and thus increase Western dependence on the East for a very critical commodity. [redacted] 25X1 25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 6
Zimbabwe: Major Chromium Facilities



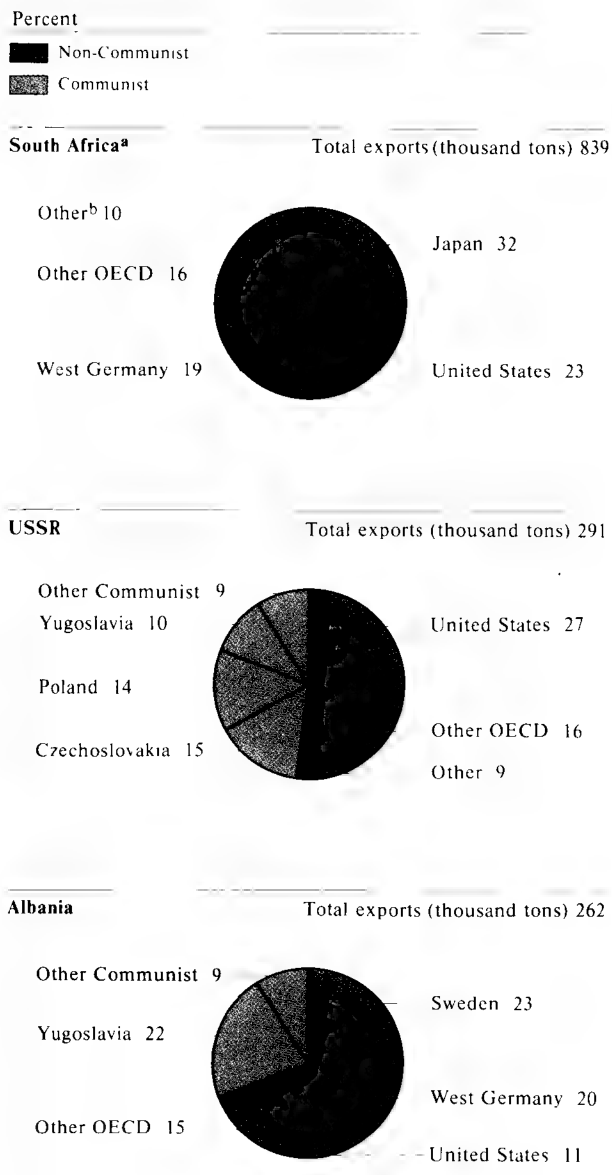
633561 2-83

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 7
Destination of Chromium Exports of Major Producing Countries, 1979



[a] May include exports from Zimbabwe.
[b] May include some Communist countries.

[redacted]
588528 2-83

Albania. Communist Albania broke off relations with the Soviet Union in 1960 and, more recently, with China and now exports its chromite mainly to OECD countries. Because these countries import only one-tenth of their needs from Albania, this Communist waif is probably more dependent on them than they are on it. While a disruption of chromite output is improbable, an embargo or change in trade partners might occur for ideological reasons. Albania by itself cannot disrupt the chromium market. Collusion with South Africa or the Soviet Union is unlikely, but Albania no doubt would take advantage of any opportunity to raise its own price to increase foreign exchange earnings. [redacted] 25X1

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Appendix B

Chromium Production and Consumption Statistics

Table B-1 [a] *Thousand Tons*
Chromite Concentrates: Production and Apparent Consumption

	1970	1975	1979	1981 [b]
Production				
World	6,000	8,280	9,971	9,210
OECD	700	1,100	1,263	865
United States	0	0	0	0
LDC	1,625	2,225	1,941	1,890
South Africa	1,425	2,075	3,297	2,865
Communist	2,250	2,880	3,470	3,590
USSR [c]	1,750	2,080	2,400	2,400
China	0	0	0	0
Other	500	800	1,070	1,190
Consumption [d]				
World	6,770	8,225	10,302	8,375
OECD	5,250	5,325	4,771	3,680
United States	1,275	800	1,100	850
LDC	800	1,700	2,944	2,275
Communist	720	1,200	2,587	2,420
USSR	570	900	1,625	1,700
Other	150	300	962	720

[a] Source: CIA estimates based on various industry and US Bureau of Mines publications.
[b] Estimated.
[c] Bureau of Mines estimates. The USSR reports only run-of-the-mine output, a figure much larger than estimated concentrates production.
[d] Apparent consumption is estimated as production less net exports.

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Table B-2 [a]
Chromite Concentrates:
Consumption, Production, and Capacity [b]

Region	Consumption		Production		Capacity	
	Apparent Level, 1979 [c] *(thousand tons)*	Percent of World Total	Level, 1981 *(thousand tons)*	Percent of World Total	Level, 1981 *(thousand tons)*	Percent of World Total
World	**10,302**		**9,214**		**11,845**	
Market economy countries	**7,715**	**75**	**5,624**	**61**	**7,830**	**66**
Canada	88	1				
United States	1,100	11				
Brazil	280	3	408	4	425	4
Mexico	50	NEGL				
Austria	57	1				
Cyprus			16	NEGL	40	NEGL
Finland	347	3	413	4	425	4
France	262	3				
West Germany	547	5				
Greece	16	NEGL	43	NEGL	60	1
Italy	232	2				
Norway	36	NEGL				
Spain	118	1				
Sweden	674	7				
Turkey	228	2	399	4	700	6
United Kingdom	92	1				
Madagascar	8	NEGL	99	1	210	2

[a] Source: Consumption is estimated from data provided in International Iron and Steel Institute, *Chromium and the Steel Industry,* Brussels, March 1981. Production estimates are from the US Bureau of Mines. Capacities are estimated from data provided by the US Bureau of Mines and industry publications.
[b] Because of rounding, components may not add to totals shown.
[c] Production less net exports.

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Table B-2 [a] (continued)
Chromite Concentrates:
Consumption, Production, and Capacity [b]

Region	Consumption		Production		Capacity	
	Apparent Level, 1979 [c] *(thousand tons)*	Percent of World Total	Level, 1981 *(thousand tons)*	Percent of World Total	Level, 1981 *(thousand tons)*	Percent of World Total
South Africa	2,027	20	2,866	31	4,000	34
Sudan			27	NEGL	40	NEGL
Zimbabwe	385	4	526	6	900	8
India	50	NEGL	336	4	350	3
Iran	80	1	30	NEGL	30	NEGL
Japan	974	9	11	NEGL	20	NEGL
New Caledonia			3	NEGL	10	NEGL
Pakistan			3	NEGL	20	NEGL
Philippines	64	1	444	5	600	5
Communist countries	**2,587**	**25**	**3,590**	**39**	**4,015**	**34**
Albania	100	1	1,143	12	1,150	10
China	100	1				
Cuba			29	NEGL	50	NEGL
Czechoslovakia	180	2				
East Germany	60	1				
Hungary	45	NEGL				
Poland	190	2				
USSR	1,625	16	2,403	26	2,800	24
Vietnam			15	NEGL	15	NEGL
Yugoslavia	287	3				

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Table B-3 [a]
Ferrochromium Alloy Consumption, Production, Capacity [b]

Region	Consumption		Production		Capacity	
	Apparent Level, 1979 [c] *(thousand tons)*	Percent of World Total	Level, 1979 *(thousand tons)*	Percent of World Total	Level, 1981 *(thousand tons)*	Percent of World Total
World	**2,833**		**2,998**		**3,857** [d]	
Market economy countries	**2,203**	**78**	**2,301**	**77**	**3,100**	**80**
Canada	35	1				
United States	478	17	268	9	323	8
Brazil	45	2	92	3	105	3
Mexico	7	NEGL	5	NEGL	6	NEGL
Austria	25	1				
Belgium-Luxembourg	17	1				
Finland	23	1	49	2	55	1
France	150	5	95	3	140	4
West Germany	263	9	60	2	130	3
Italy	116	4	43	1	52	1
Norway			13	NEGL	36	1
Spain	46	2	20	1	24	1
Sweden	120	4	219	7	220	6
Turkey			30	1	60	2
United Kingdom	78	3				
South Africa	106	4	804	27	825	21
Zimbabwe	29	1	200	7	390	10
Australia	12	NEGL				
India	16	1	25	1	27	1
Japan	631	22	378	13	705	18
South Korea	3	NEGL			2	NEGL
Taiwan	3	NEGL				
Communist countries	**630**	**22**	**697**	**23**	**757** [d]	**20** [d]
Albania					30	1
China	92	3	92	3	92 [d]	2 [d]
Czechoslovakia	22	1	28	1	28 [d]	1 [d]
East Germany	24	1	21	1	21 [d]	1 [d]
Hungary	9	NEGL				
North Korea	4	NEGL				
Poland	52	2	52	2	52	1
Romania	16	1				
USSR	397	14	432	14	450 [d]	12 [d]
Yugoslavia	14	NEGL	72	2	84	2

[a] Source: US Bureau of Mines, *Ferroalloys, Preprint From the 1981 Minerals Yearbook* and International Iron and Steel Institute, *Chromium and the Steel Industry*, March 1981.

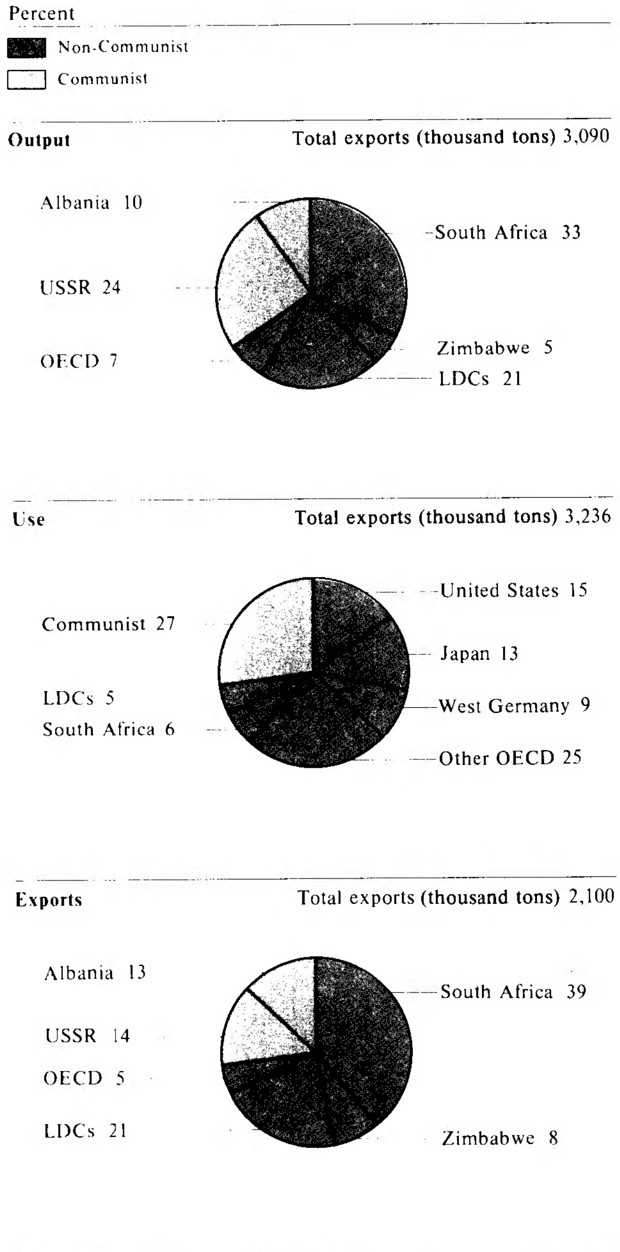
[b] Because of rounding, components may not add to totals shown.
[c] Production less net exports.
[d] Minimum level; data for some countries are incomplete.

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Figure 8
World Distribution of Chromium Output, Use, and Exports, 1979



588523 2-83

25X1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1

Approved For Release 2008/01/15 : CIA-RDP84S00558R000100100002-1